solplan review

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INSIDE....

In recent years a number of new techniques for sealing houses have been introduced. Tight draft-free construction is important to ensure a durable building envelope, as well as for energy conservation. Rob Dumont reviews a number of ways main air leakage locations can be sealed. He suggests that when relying on polyethylene as air and vapour barrier, much of the sealing of poly sheets may be unnecessary.

The thermal resistance of log walls has been a subject of controversy for some time. CMHC recently had log walls tested. We present the study findings.

HOTCAN has become an important tool to assess and predict the energy performance of houses. However, monitoring indicates that energy consumption may be higher than expected. We review the reasons for the discrepancy.

Loose-fill attic insulation is seldom installed as called for. We review where the shortages are, and what a contractor can do to ensure he gets what he's paying for.

Other items include test results of energy efficient furnaces, new product from vanEE, and insights on alternate ventilation strategies.

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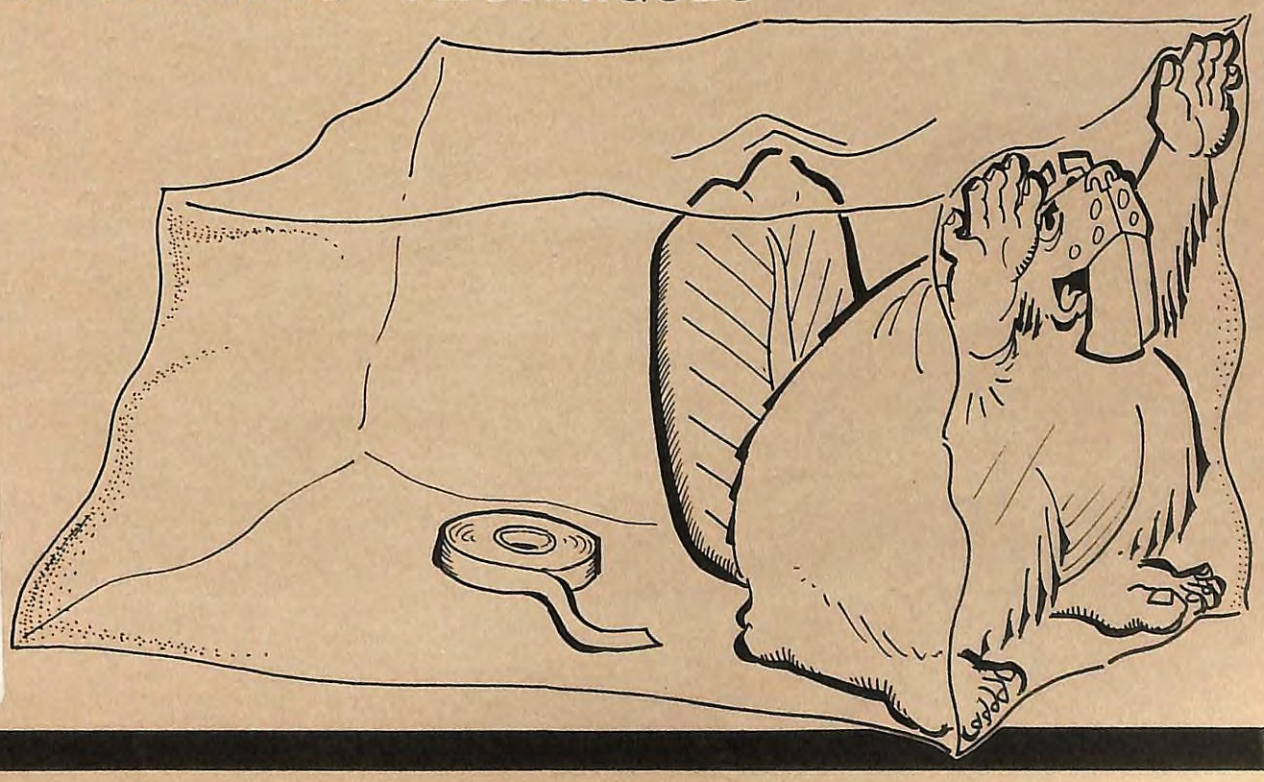
AIR SEALING TECHNIQUES



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Richard Kadulski

FROM THE PUBLISHER

Having seen the publicity for the 1987 Dream Home at the Toronto ("National") Home Show, we wonder what is the purpose? The sprawling 5300 sq.ft. house, complete with indoor spa and maid's quarter, has every luxury feature imaginable (except, perhaps the indoor swimming pool).

Is the object to build an opulent palace pandering to the dream of over-achieving, self-centered Yuppies? Is it a showcase of new products, techniques and designs? What kind of image is the industry trying to project - that quality housing is only for the upscale, wealthy buyer?

The indulgent image projected raises a serious concern about the direction the housing industry seems to be taking. It is disturbing to see this, as the number of homeless is increasing and many, especially the young, cannot afford decent housing. The only way many can afford a starter home is to mortgage themselves for the rest of their life - for a house of doubtful quality.

Where is the drive to produce modest, quality housing that the average person can afford? It may well mean changing public expectations to more realistic goals. Display homes and Home Shows are an important vehicle to change public expectations.

The housing industry does not want outside interference in the marketplace. But if it does not start to address the issue of how to deliver **quality, affordable** housing, it will only set the stage for more active government participation - something that could be counterproductive.

The time is **now** to start dealing with these issues - not after outside parties step in!

Richard Kadulski
Publisher

VENTILATION ALTERNATIVES:

AIR QUALITY IN DWELLINGS

A recent study in Sweden suggests that ventilation requirements of the Swedish Building Code may not provide acceptable air quality to bedrooms. It suggests that conventional fresh air supply to bedrooms may not provide adequate control of relative humidity and carbon dioxide.

The study suggests an easy and inexpensive way to improve the air is to install exhaust ports in bedrooms. Outside air is brought into the house through slot valves in the window frames. At the same time it is possible to reduce the total air change rate to about 0.3 air changes per hour (which will result in a not inconsiderable saving in energy).

Measurements of air change rates have been made (using both tracer gas and hot wire anemometer) in buildings equipped with extraction terminals in the bedrooms and in similar "control" buildings. The control houses have a traditional ventilation system with exhaust ports in all bathrooms, laundry, and kitchen.

The results of the study show that the indoor air quality in the bedrooms is considerably better when exhaust terminals are installed in the bedrooms than when air is exhausted in the traditional way.

No moisture or mould problems have been found and, what is most important, the occupants consider the indoor air quality to be good.

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TIGHTENING-UP HOUSES: AIR SEALING TECHNIQUES

by Rob Dumont

Construction practices have improved in recent years. The importance of sealing building envelopes has been recognized, not only for reasons of energy conservation but also for technical concerns of structural durability.

In the past decade, a large number of air sealing techniques for residences have been introduced. Using these builders have been able to reduce whole house leakage values to below 1.5 air changes per hour at 50 pascals. A disadvantage of some of the techniques has been increased cost compared to conventional construction practices.

However, tight building envelopes will become the norm since the latest changes to the National Building Code require tight construction.

In this article we take a look at research data on the location of common air leakage paths in residences and suggest some improved and simplified techniques for air sealing.

The two dominant air leakage locations are the ceiling-interior partition joints and the foundation-sill area.

To date, the most popular air sealing technique has been the use of a polyethylene vapour barrier which also serves as the air barrier for the structure. Generally, great care is taken in sealing all the joints in the poly sheets.

It is my belief that much of the joint sealing with the poly sheets is unnecessary, as the gypsum board can also serve as the air barrier.

In houses where techniques to reduce air leakage have been used, the air leakage values as measured by a blower door test are routinely reduced below 1.5 air changes per hour at a pressure difference of 50 pascals. This figure represents a significant reduction from readings of about 4 to 10 air changes per hour at 50 pascals for typical Canadian houses that do not incorporate any special sealing measures.

I want to review the relative importance of various air leakage paths in houses, and suggest improved details that could reduce the cost of air sealing. I will concentrate on wall systems using poly vapour barrier systems placed under gypsum board (space does not permit a discussion here of ADA - the air tight drywall approach.)

For typical Canadian houses, the most common leakage areas are:

a) Joints between interior partitions and ceilings.
b) Joints around the floor joists.
c) Fireplaces.
d) Ductwork in unconditioned spaces.
e) Pipe and duct penetrations.
f) Attic hatches.
g) Window or wall air conditioners.
h) Windows and leakage around window frames.
i) Doors and leakage around door frames.
j) Electrical outlets and switches.
k) Basement floor drain.

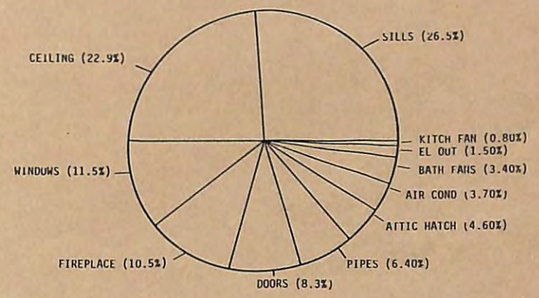


Fig.1 Air leakage distribution (by source) in a typical bungalow

Just how important each element is can be seen in the pie graph in fig.1. These figures are based on calculated values for a one story house. In 2 or 3 story houses, wall components are a more important, as there is a smaller fraction of air leakage through the ceiling.

This example is similar to typical houses. Obviously, the greatest effort should be put to reduce air leakage in the most leaky locations. The two dominant air leakage locations are the sill-foundation area and the air barriers and vapour barriers, ceiling-partition wall leakage.

Together they can amount to almost one-half of the total leakage area for this example house. Electrical outlets account for less than 2 per cent of the leakage (but in some cases they can be 10% or more of total leakage). Windows and doors and the adjacent framing leakage amount to about 20%.

Air Barriers and Vapour Barriers

To control air leakage through the envelope of the structure, an air barrier is required. A good air barrier will prevent the movement of warm moist air into the structure where condensation and deterioration can take place.

For many applications interior gypsum board wall finish can serve as the air barrier provided that some means is used to ensure that gypsum board is continuous and that joints between the sheets have been properly taped. For example, very little air leakage will occur through a ceiling that has gypsum board installed provided the board is continuous and the joints have been properly taped. Air leakage can occur at penetrations of the gypsum board if proper sealing methods are not incorporated.

In addition to providing an air barrier, one must also provide a vapour barrier in the envelope. Gypsum board by itself is not a satisfactory vapour barrier. In Canada since about 1960 the most popular form of vapour barrier in residential construction has been polyethylene sheeting. Other vapour barriers, such as waxed or asphalt coated paper and vapour barrier paints have been used, although much less frequently.

It is possible to use the gypsum board as the air barrier in some parts of the structure, and a poly vapour barrier in other parts of the structure to provide the air barrier. Using this technique, it is possible to omit sealing the poly sheeting in areas of the structure where the gypsum board can be installed in a continuous manner (for example, on ceilings where the board can be installed before the interior partitions are erected.)

In other parts of the structure, such as in the area around the floor joists, the use of gypsum board for air sealing would be difficult. In this part of the house, a well-sealed vapour barrier can serve as the air barrier.

Thus, I am suggesting that the gypsum board be used as the air barrier where appropriate, and in other locations to use polyethylene sheets that are sealed as the air barrier. The advantage of this technique is that far less caulking and sealing of vapour barrier sheets is required.

Sealing Polyethylene Sheets

A number of methods have been used to provide a tight seal between sheets of polyethylene,(Fig 2) including:

a) Use of acoustical sealants.
b) Use of tape.
c) Use of a spline.
d) Use of a folded joint.
e) Use of a large overlap (usually a minimum of about 16 inches).

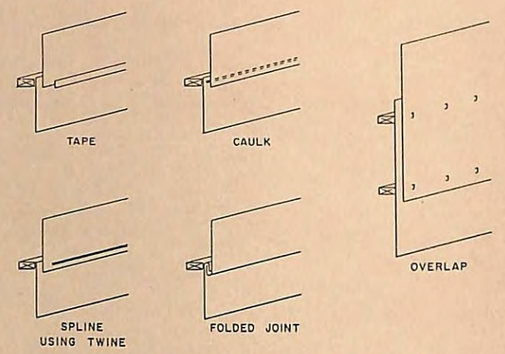


Fig.2 Alternatives for sealing polyethylene joints

Ceiling Air Leakage

Ceilings tend to be leaky for two main reasons:

1. The many joints that occur in the ceiling where the interior partitions intersect the ceiling.
2. The large number of penetrations by services such as plumbing vent stacks, chimneys, electrical wiring, recessed light fixtures, attic hatches, exhaust fans, and ductwork. (Fig. 3)

Standard practice has been to install the vapour barrier and gypsum board after the interior partitions are up. However, this way the vapour barrier is not continuous and many paths for air leakage are available.

While it is possible to achieve a good air seal by careful attention to sealing all the joints in the vapour barrier at this stage, the amount of labour time involved is considerable and the effort can be negated during the installation of the drywall on the ceiling if proper care is not taken.

A more desirable approach to obtain a tight air seal is to delay the erection of the non-structural interior wall partitions until after the ceiling vapour barrier and wallboard is installed. Longer gypsum board and larger vapour barrier sheets can be installed in the ceiling and a continuous air and vapour barrier can be more easily achieved. Houses built with trusses are

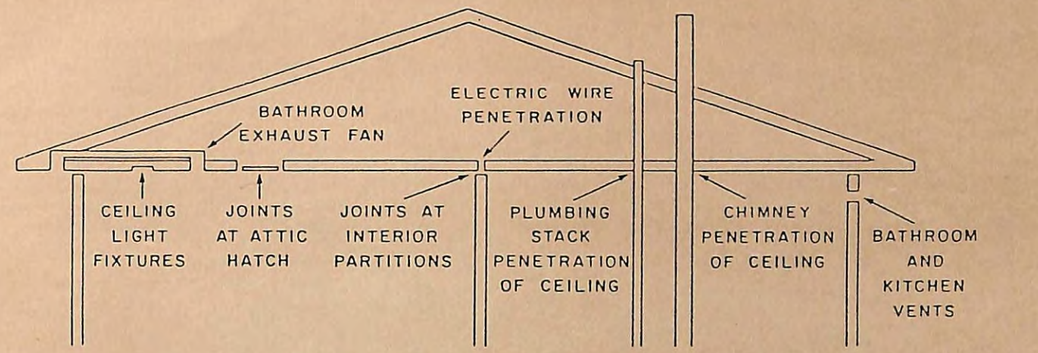


Fig.3 Ceiling air leakage paths

especially easy to build this way.

In this way it is possible to avoid caulking or taping the vapour barrier sheets on the ceiling as the unbroken gypsum board serves as the air barrier in this location. If wide vapour barrier sheets are used, very few joints will be present in the vapour barrier.

This technique requires some revised trades scheduling, as normal framing sequences are altered.

Joints at Floor Joists

The joints around the floor joists are a second major source of air leakage in typical residences. An expanded view of potential air leakage locations around the floor joists is presented in figure 4. To have an effective air seal, continuity of the seal must be maintained.

One technique that has been used is to wrap the floor joist headers with poly during the framing stage. The vapour barrier on the outside of the floor joist must always be thermally insulated so as to prevent condensation occurring at this location. In most Canadian climate conditions (except the far north), about twice as much insulation R-value should be placed outside the vapour barrier as is placed inside. In the far north the ratio should be greater.

Other alternatives have been tried, including using caulking compound to seal between the gypsum board and the framing; between the gypsum board and the floor; and sealing the spaces between the floor joists with rigid blocking and caulking. The former technique has generally proven to be more successful.

Figure 5 shows an alternate detail that

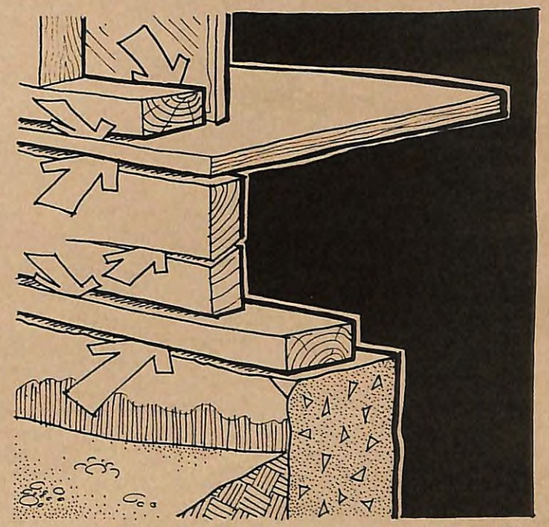


Fig.4 Air leakage sources around sill plates

can be used to limit air leakage where floor joists rest on a concrete. Spunbonded polyolefin paper (e.g. Tyvek) on the outside acts as an air barrier. Because it is permeable to moisture, it can be used on the exterior of the building. Note that the insulation which is placed on the inside of the floor joists still requires a vapour barrier.

Where green lumber is used, the header should be notched with a saw cut to allow the trapped moisture to escape.

Joints between Wall and Window/Door Jambs

Another major source of potential air leakage is the gap between the window and door frames and the rough opening.

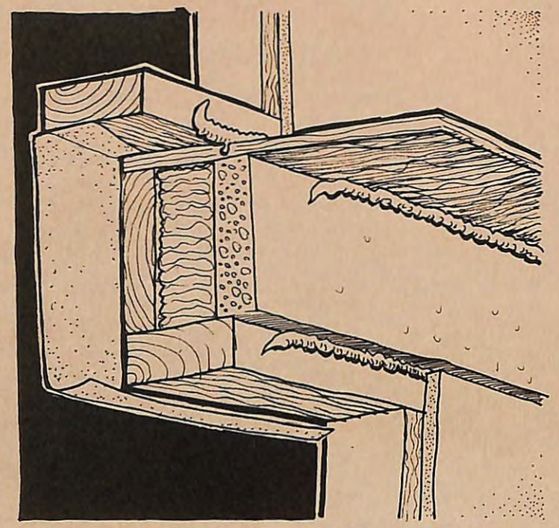


Fig.5 Alternative method to limit leakage at sill plate

Typically, the rough frame opening is going to be up to 1 inch wider and 1/2 inch higher than the window/door frame.

Although a number of different sealing techniques have been recommended, one of the simplest techniques for use with wood frame windows seems to be the one shown in figure 6. The first step is to lightly push strips of batt insulation into the gap between the rough opening and the frame of the window or door. The wall vapour barrier is carried over the window, with some slack allowed in the vapour barrier; when the finish trim is placed on the face of the window frame, the vapour barrier is sealed to the outer face of the window frame using acoustical sealants and staples. To provide a durable seal, a tape such as electrical tape is placed over the poly before the staples are placed.

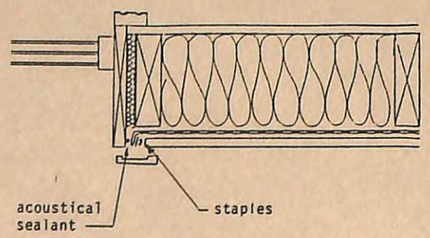


Fig.6 Technique for air sealing around window and door frames

One problem with this approach is that if the front of the window frame is not parallel to the gypsum board on the wall, the finishing carpenter may damage pour barrier when planning the face of the window frame. To reduce the possibility of damage, the vapour barrier should be pulled back from the window frame while the carpenter is trimming the front edge of the window. A good quality sealing tape can often be used to repair damage to the vapour barrier.

An alternative detail is to use polyurethane foam to seal the gap between the edge of the gypsum board and the window frame as shown in figure 7. However as the foam is a more difficult product to use, the former technique is to be preferred.

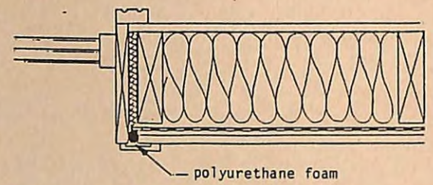


Fig.7 Alternative for air sealing around window and door frames using polyurethane foam

Care must be taken with the foam not to use too great a quantity, as the expanding foam can distort the window frame. Foam backer rods (used in commercial construction) can also be used to fill gap, but the backer rod material must not be crushed, or it will not be effective at all.

Electrical Outlets

In a typical house, about 20 outlets and switches are located in the exterior walls and ceilings. A number of different techniques have been used for sealing such outlets. These include:

a) Locating the switches and outlets on non-exterior walls and ceilings.
b) Using a piece of polyethylene about (18 inches square) behind the electrical box.
c) Using a pre-formed plastic vapour barrier box.
d) Using wall plate foam gaskets.

Electrical outlets and switches make up only a small fraction of the total leakage in typical residences. However, if all other major leakage sources are sealed, they can become significant.

Probably the easiest technique is to use a plastic electrical box and sealing all penetrations by the wiring. A foam gasket is then fit under the cover plates, and child-proof socket prongs inserted into the sockets.

An alternative is to use preformed plastic vapour barrier boxes which are installed outside the electrical box. Penetrations of the vapour barrier box are caulked. The vapour barrier box must have solid backing to which the wall vapour barrier is sealed. This often proves to be quite time consuming.

A simple technique often used is making plywood boxes the depths of the electric box which fit between two studs. The joints and penetrations are sealed, and the box insulated inside and outside.

Pipes and Ducts

Pipes that penetrate the envelope of the house are significant sources of air leakage. One should try to minimize the number of such penetrations.

For instance, houses with unheated crawl spaces should keep forced air ducts and plumbing runs inside the shell, by use of dropped ceilings. Plumbing and vent stacks should be interconnected where possible on the inside to minimize ceiling penetrations.

Holes for ducts and stacks should match the dimension of the pipe as closely as possible. The hole can then be caulked with polyurethane foam, or gasketed with a sheet neoprene rubber.

Ceiling vent pipes, especially plastic ones, can experience large movements due to thermal expansion and contraction which is where neoprene gaskets offer a good solution.

Materials

We've talked about a variety of ways to caulk and seal to create an airtight envelope. But just what are the caulking materials to use?

There are a number that can be used, each depending on the location and and size of opening to be sealed. When choosing a product, it is important to consider the durability of the product under the conditions it will be exposed to over the lifetime of the structure (not just the first few months or years). Sealants and caulking materials must be non-hardening and resilient.

For sealing polyethylene, the most commonly used material is acoustic caulking. This is a material that will not set or harden over its lifetime - and as anyone who has used it will know, it is very messy.

To caulk gaps between two components (e.g. along the floor sill/sub-floor joint) acrylic or butyl caulks seem to be reasonably effective. They do set up, and form a skin, but do not harden completely, and maintain a reasonable degree of flexibility over a long time. However, they will not bridge large gaps, where the caulk could pull away and re-open the gap.

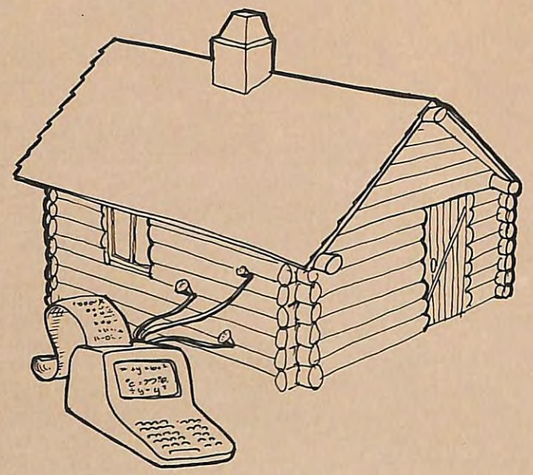
Foam ropes or gaskets are excellent sealants, provided they are installed carefully, and that they can maintain their resiliency. If one is crushed during installation or in use , and does not recover its original shape, then it will be of no use. Foam backer rods are designed to be a backing for caulking, to bridge a gap, and not as the total filler. Most cannot tolerate excessive forces (such as would be the case under a sill plate).

Polyurethane foam is also used as a sealant. Because it is foamed into place, and expands, it will tend to fill all nooks and crannies. However, it must be applied only in accordance with the manufacturers recommendations. It is sensitive to temperature conditions, and cannot be used in extreme cold conditions. Improper application may not provide a uniform coverage, and some shrinkage or excessive gas pockets could reduce its effectiveness.

A number of techniques for air sealing houses have been presented. As with any relatively new field, there is a wide scope for innovation as builders discover effective, simple solutions. The main point of this article is that the main leakage areas in most new houses are in the ceiling and at the floor joists. To reduce air leakage, these are the areas to concentrate on first.

Rob Dumont is a research engineer in Saskatoon, Saskatchewan. He has been active with low energy construction and research since the early 1970's.

We would welcome comment from readers on details and methods they find useful. In future issues we will be taking a closer look at recent developments with ADA - the Airtight Drywall Approach.



R-VALUE OF LOG WALLS

The thermal resistance of solid log walls has been a subject of controversy for some time. Canada Mortgage and Housing Corporation recently commissioned a study intended to provide field data to compare theoretical R-values to actual measurements.

Log home builders have claimed for a long time that the thermal resistance of log walls is higher than standard reference data would indicate.

Log home builders have argued that the actual net heat loss through log walls is less than would be calculated using simple heat conduction formulae because of the benefits of solar energy storage in the log's mass.

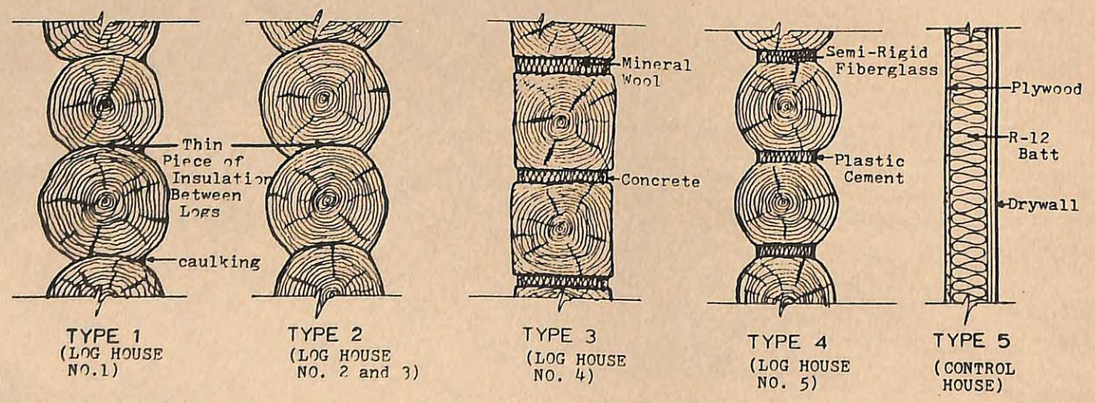
However, this is a difficult feature to analyze in a short term test because of the variable pattern of solar energy availability. The tests in this study were limited to north walls only, to limit the effect of stored solar energy. Thus the results do not include any solar storage benefits that might accrue from the massive nature of log walls. Rather, they only measure R-values of the walls.

The testing of the thermal resistance of log wall systems had three main objectives:

1) To measure, for known inside/outside temperature conditions, the actual heat loss through several types of log walls and thus to determine their effective thermal resistance.
2) To compare the theoretical and actual thermal resistance values of log walls.
3) To conduct similar measurements for standard frame walls in order to produce a base against which the performance of the log walls can be interpreted.

Testing was carried out on five log houses and one conventional wood frame house. An infrared thermographic scan was performed on each wall section to ensure that there were no unusual thermal features (such as voids in the joints) in the test section that might bias the analysis.

Three types of log wall construction were tested: standard round log wall; square log-chinked wall; and a modified round log wall. Figure A shows the construction techniques of the test houses.



Log Wall Construction Techniques Examined in the Study

Three log houses tested were less than three years old. The construction of these is based on a Scandinavian technique in which a longitudinal round groove is hewn into the bottom of each log. Each log is hand scribed so that the groove matches the contour of the log on which it is to be placed. A thin piece of mineral wool is placed in the groove to help fill any voids between the logs.

The square Log-Chinked Wall house is about eight years old. The log walls are 10"x10" squared cedar logs tied together by steel bolts. The insulated joints are covered both inside and out with metal lath and parged with concrete.

The modified round log wall house was two years old. It was built using a construction technique similar to the squared log house but with round logs. The top and bottom of each log is flattened to create a flat face of about 10". The logs are placed one on top of another separated by about 1-1/2" of semi-rigid fiberglass insulation. Joints are sealed on the interior and exterior surfaces with reinforced plastic cement.

The "Control" house was a conventional wood framed house about eight years old. The interior is finished with 1/2" drywall on 2x4" wood stud frame wall insulated with R 12 batt insulation.

The wall of the control house was tested to have an effective R13.7. This compares with a calculated value of R12.7 (calculation includes the effect of thermal bridging through studs based on actual stud area within the test wall area). The field result is within 7% of the theoretical value.

In all cases the measured R-values for the log walls are below the calculated R-values. For the round pine logs, the measured R-values were, on average, about 20% below the calculated R-values. The cedar wall section was found to be only about 9% below the calculated R-value determined (using an R1.33 per inch of thickness).

The results show that the modified round log wall section house had the highest effective R-value: R14.3, while the wall section tested in the standard round log house, has the lowest effective R-value: R10.6.

From the results of this study it appears that the current CMHC rating for log walls (R1.33 per inch thickness) is generous.

As could be expected, there is a direct relationship between the apparent resistance of each of these log wall systems and the heat loss observed near the joints. The walls of houses which had interior and exterior joints sealed, have the best apparent R-value.

The issue of air leakage may only be important in those wall sections where the joints were not caulked. However, over time as the logs shrink and shift, the caulked joints may deteriorate making air leakage a much greater concern. In this study, the effects of air leakage through joints was eliminated by the presence of the test apparatus, so that total heat loss for walls with high air leakage would actually be higher.

The thermographic scans also pointed to extra heat loss at wall corners. The extra losses at the corners appear to be independent of the degree of airtightness.

The results indicate a range of effective R-value of the log walls from a minimum of R10.6 to a maximum of R14.3 while the conventional wood frame house had an effective R value of 13.7.

All apparent R-values were found to be below the recognized values.

However, as the nominal R-value is in the 10-14 range for a 10-12" thick wall, it is not likely to compare to a superinsulated wall with an R-value of 25-30. Also this ignores the effect of heat loss and discomfort due to air leaks in the wall.

(It would be interesting to see the results of a blower door test done on a 2 or 3 year old log house! If any readers know of such tests having been done, please let us know).

Energy Efficient Building
Consulting Service
HOTCAN Analysis
Design & Consulting

richard kadulski architect
b.a., b.arch., m.a.i.b.c.
1269 howe st. vancouver, b.c. v6z 1r3
telephone: (604) 689-1841

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HOTCAN: HOW ACCURATE IS IT?

HOTCAN and the new HOT2000 computer software programs were developed for use by the R-2000 Program. Both software programs provide house energy use analysis, and calculate the energy use targets as defined by the R-2000 Program.

Since the energy use target is such a key part of the R-2000 Program, and is used to assess all houses that are entered in the Program, it is appropriate to ask just how accurate these computer programs are. HOTCAN has been in use for several years and more detailed monitoring results are now becoming available.

Monitoring shows that actual energy consumption often is **higher** than predicted by HOTCAN. Does this mean that the program is not accurate? Not necessarily.

A review of the results shows several items that can cause a difference between predictions and actual performance.

When predictions are made, assumptions have to be made. The R-2000 Program uses one set of assumptions, (meant to reflect the "average" household) by which all houses are judged. This way, a uniform set of comparisons between houses is available.

A range of valid assumptions can always be made. If one is doing an analysis for a specific project and homeowner, it can be tailored to the real needs of that family, which may differ from the assumed characteristics of an 'average' family. (Just as there are no families with exactly 2.7 children, there is no 'average' family even though that may represent a statistically representative family).

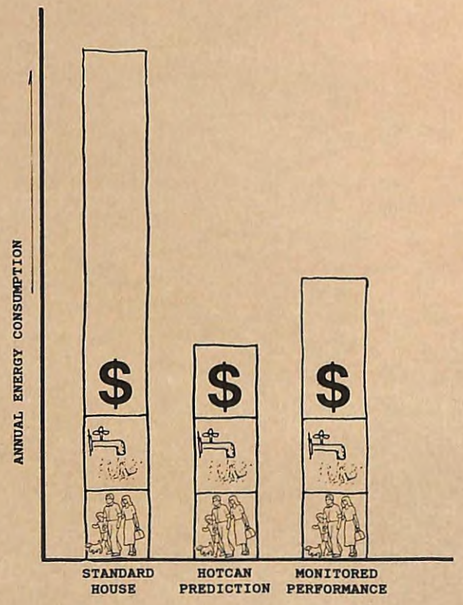
The R-2000 Program uses only nominal R-values for insulation in a construction assembly. No recognition is made of the true value for the total assembly. This is done to simplify procedures, and assumes that the total R-value will be approximately the same. (To try to estimate actual R-value is tedious, complex and not always justified). However, with higher insulation values this does not always work, as framing can be a significant thermal bridge that could lower the overall R-value.

Most monitoring activity tends to be done during the first year, during which time the house is drying out (especially a slab on grade or basement floor), which leads to grater energy consumption the first year. First year data can be misleading.

In addition, assumptions are made that all solar gains received by the house are utilized. However, large gains into a house that does not have provision for using the solar energy (e.g. lack of thermal mass or lack of distribution system to redistribute heat gains) can be counterproductive. If the solar heat is not useful, it will be dumped by the house.

Another major problem is overestimating solar gains. When an analysis is being made, there is not always enough information to show what actual shading factors may be. On the site, beneficial solar gains for a house may not be there if there are large trees shading the house.

Each one of the assumptions, on its own, is reasonable. The errors they cause do not necessarily create an excessive problem - maybe only 10-15% but they lead to greater energy consumption because energy consumption is the difference between total load and internal gains plus solar gains.



Comparison of energy consumption by HOTCAN prediction of a house to meet R-2000 criteria against monitored performance.

In a low energy house, energy consumption is low, so that even a modest increase seems to be much more significant than it might be otherwise. Any increase in the purchased energy is over and above that of the predictions. If a homeowner expects to pay $1000 for heating, and actually gets $1100 heating bills, it's not a major problem. But if he is expecting to pay $100 and gets a $200 bill, then it becomes significant to him.

The graph illustrates the relative portions of purchased energy for space heating, internal gains, and domestic hot water. Any small change in space heat requirements is much more quickly noticed in the low energy house.

The monitoring results point to need to reconsider the validity of the energy targets. While it may be appropriate to try and achieve near zero-energy houses, it is difficult to justify it at this time of low energy prices, so the marketplace will not accept it.

Houses that come close to meeting current R-2000 targets are significantly better than 'conventional' houses presently built. More homes built within the program would raise market awareness and improve the quality of residential construction.

In some areas of the country there has been an added complication to complaints of excessive heating bills and incorrect predictions. Homeowners' complaints of high heating bills are related to false expectations. In a number of instances it has been a case of a homeowner moving from a gas heated house (where gas is very inexpensive) into an all electric house. In these cases the net energy consumption is considerably lower than would be the case in his previous home, but the more expensive fuel cost means the homeowner is paying more than if he had stayed with the lower priced energy source.

THE IMPORTANCE OF VENTILATION

There is no subject directly connected with domestic life on which there is so large an amount of popular ignorance as ventilation. When one is hungry, nature drives one on to cry out for food and drink; and, as a necessity makes these the most immediate and pressing of all needs, one undertakes to satisfy them before all others. Yet persons have been known to live without food for weeks, though anyone wholly deprived of air will die in minutes.

This lack of attention to ventilation arises from the fact that the poison of breathing bad air is a slow one, and though its effects are as certain as those which follow from taking poison. However, the effects become evident very slowly.

Nature does not immediately protest against impure air as against want of food and water, and, therefore, we go on from day to day, suffering the accumulated evils resulting from our ignorance, and only wondering at our want of physical heath and spirits.

Having pointed out the ignorance regarding a supply of fresh air in our living rooms, and the necessity of providing for it, let us investigate the simplest and best modes of producing a sufficient supply of fresh air at all times.

Fond as we are of improvement, the greatest possible improvement in a house - ventilation - is as yet a thing almost unknown in this country.

Seems obvious, doesn't it? Would you believe that this item is reprinted (virtually word for word) from an American book published in **1860**? It is the introduction to a chapter on heating and ventilation.

It seems that we still have something to learn (as obviously the lesson was lost over time, if ever learned). As we improve our building practices, and begin to pay more attention to the quality of the indoor environment this becomes ever more important. So does the recognition that passive control of contaminants - at their source is the most effective (and economical) means of improving indoor air quality.

PERFORMANCE TESTING: ENERGY EFFICIENT FURNACES

To reduce energy loss due to inefficient furnaces, manufacturers have begun to introduce improved energy efficient models. To determine if these new models are as efficient as claimed, and whether they are economical, a study of furnace efficiency was done by the University of Alberta.

Six gas-fired furnaces, typical of designs marketed in Alberta since 1980, were tested to determine their fuel efficiency and cost effectiveness. A standard furnace was tested for comparison.

In conventional furnaces, heat losses occur for several reasons. These include:

1) The limited size of the heat exchanger, which does not allow all of the combustion heat to be transferred to the air that is circulated throughout the house. This means that combustion gases leave the heat exchanger and enter the flue while still quite hot, carrying with them a significant portion of available fuel energy. This is called sensible heat loss, and can account for 15 to 20% of total heat losses.
2) Latent heat loss is the energy present in uncondensed water vapour, a major component of flue gases. This can account for up to 10% of total heat loss.
3) Loss of heated indoor air up the flue during furnace operation and especially during shutdown. This can account for 8 - 15% of total heat loss.
4) Heat lost by a continuous pilot light can account for 5 - 7% of heat loss.

In new furnaces these losses have been reduced either by making changes to standard designs or introducing different design concepts. They generally use a more efficient design for the furnace heat exchanger - in some cases also recovering heat from the flue gasses, eliminating the need for a flue (as in the 'condensing' type of furnace).

The **ICG Conserver**, employs a motorized flue damper to prevent warm room air from escaping up the flue. This is used with electronic spark ignition, thus eliminating energy losses caused by a continuous pilot light.

The mid-efficiency **AIRCO Turbo** employs electronic ignition and an induced-draft fan to control the intake of combustion air, achieving more efficient combustion with a heat exchanger which is designed to reduce losses of sensible heat.

The **ICG Standard**, a conventional furnace, was tested for reference purposes.

In the laboratory, **steady state fuel efficiency** was measured using standard procedures used by furnace manufacturers. Each furnace was operated continuously, which allows measurement of maximum efficiency. However, this type of operation is not an accurate representation of actual operation in a house, where furnaces cycle on and off throughout the heating season and then seldom turn on for several months. For this reason measurements of seasonal fuel efficiency using a procedure proposed by the Canadian Gas Association were made to more accurately imitate real heat losses.

Measured seasonal efficiency of the conventional furnace (67 to 72 %) was higher than the expected range of 55 to 60%. This may be due to the colder and harsher Edmonton climate.

Table A summarizes the findings of the study.

FURNACE	MFGR CLAIM	MEASURED EFFICIENCY		
		STEADY STATE	SEASONAL (LAB)	SEASONAL (FIELD)
ICG STANDARD	77%	72%	67%	71%
ICG CONSERVER	77	69	76	80
AIRCO TURBO	84	81	83	91
ICG ULTIMATE	92	92	92	92
LENNOX PULSE	96	97	96	98
AMANA ENERGY COMMAND	96	96	95	92

One way of expressing the economics of furnace ownership is to calculate the payback period, which is the time required to recover the incremental costs in excess of conventional furnace costs through lower fuel bills. A medium efficiency furnace can have a payback of 4-8 years (depending on location and energy costs).

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- producing presentation graphs (if H-P plotter available)

Cost: $295.00

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to predict building energy consumption and thermal comfort

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Waterloo, Ontario
N2L 5J1
(519) 884-6421

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PRODUCT UPDATE:

NEW FROM vanEE

Conservation Energy Systems Inc. has announced the introduction of a new heat recovery ventilator.

The **vanEE 1000** Series is a 100 cfm (47 l/s) heat recovery ventilator designed for applications such as small detached homes, townhouses, condominiums, manufactured homes, mobile homes, work trailers, basements, and meeting rooms.

The unit has been sized to match upper cabinets, allowing concealed installation in laundry or storage rooms. It can also be wall-mounted, below a dropped ceiling which conceals and forms part of the necessary ducting.

The patented design blends efficient, centrifugal fans with an efficient polypropylene heat exchange core to provide a balanced flow of stale exhaust air to the outside and fresh, filtered, warmed outside air to the inside, allowing occupant control over indoor environments.

The 1000 Series has been designed for easy installation and servicing.

The manufacturer claims an efficiency at 0°C of 70% at 100 cfm, and 80% at 50 cfm. At -25°C, it is 68% at 100 cfm, and 78% at 50 cfm.

For information:
CES Inc.
3310 Millar Ave.
Saskatoon, Sask. S7K 7G9
Tel: 306-242-3663

Ontario Research Foundation test results for this unit or any of the other new, small (100 cfm or less) units are not yet available, as standard procedures require tests to be carried out at air flows that are higher than these units (by design) can provide. We understand that work is going on to change this, and tests should be done soon.

COMING SOON:

Topics we are preparing for coming issues include **indoor air quality**: what are the issues, how to deal with them; update on **radon**; **design tools:** what is available, and how to take advantage of them; plus more on the latest research, products, construction techniques, and much more.

LOOSE-FILL ATTIC INSULATION: ARE YOU GETTING WHAT YOU'RE PAYING FOR?

It has come to our attention that insulators blowing loose fill insulation do not deliver what they claim to. The suggestion made is that few (if any) installers in the country actually install what they are being contracted and paid for.

Due to the nature of loose fill blowing insulation, it is easy for an installer to shortchange a customer. In order to move the product the properties of the material require it to be 'puffed-up'. However, the glass fibers can be puffed much more than required so a deep layer can leave the impression that the required insulation is there.

Too often builders call for a certain depth of insulation rather than a certain **R-value**. Some builders go so far as to mark a chalk line for the depth of insulation they are expecting. If the installer has applied that amount, as determined by a quick visual inspection, then the builder is satisfied.

But a **lower density** than is required for a given R-value recommended by the manufacturer will not provide the requested **R-value**. The over-puffed insulation will settle quickly, yielding much lower R-values than called for, and contributing to greater heat loss.

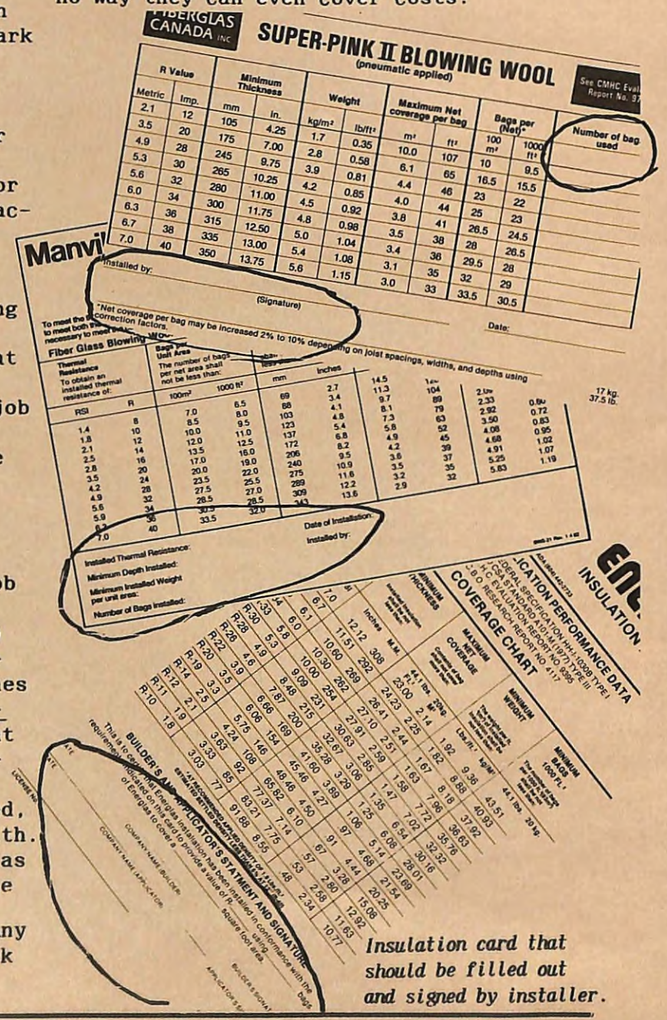
The only way to ensure that you get what you pay for is to measure an insulation sample for weight and density after the job is done. This can be expensive and very impractical. The easy way is to calculate the number of bags required for the job (information on coverage is provided by manufacturers), and to ensure that the right number of bags are used - in other words do a bag count at the end of the job (but be sure that the bags are only from your job and not someone else's as well!)

Each insulation manufacturer has an insulation coverage card (similar to the ones illustrated). Every contractor should <u>insist</u> on getting a signed card spelling out the details of what he has installed, including the number of bags. Then if a shortage in the installation is discovered, he has something in writing to go back with.

You should be aware that products such as rock wool and cellulose insulation, by the nature of their fiber structure, are not subject to the problem of over puffing. Any settlement in these tends to be very quick and modest.

Why is there so much cheating going on? It is a reflection of a lack of serious supervision of installers, and an extremely competitive marketplace.

The price of alternates to fiberglass insulation (cellulose and rock wool) is much cheaper than loose fiberglass (list price for fiberglass in B.C. is about $20.00 per bag, while rockwool is about $10.00 per bag). In order to compete with alternate products, fiberglass installers quote a price that is close to the lower priced insulation, with the full expectation that no one is going to seriously monitor the job site installation, otherwise there is no way they can even cover costs!


FIBERGLAS CANADA INC.

SUPER-PINK II BLOWING WOOL
(pneumatic applied)

See CMHC Eval. Report No. 97

R Value Metric	R Value Imp.	Minimum Thickness mm	Minimum Thickness in.	Weight kg/m³	Weight lb/ft³	Maximum Net coverage per bag m²	Maximum Net coverage per bag ft²	Bags per (Net)* 100 m²	Bags per (Net)* 1000 ft²	Number of bag used
2.1	12	105	4.25	1.7	0.35	10.0	107	10	9.5	
3.5	20	175	7.00	2.8	0.58	6.1	65	16.5	15.5	
4.9	28	245	9.75	3.9	0.81	4.4	46	23	22	
5.3	30	265	10.25	4.2	0.85	4.0	44	25	23	
5.6	32	280	11.00	4.5	0.92	3.8	41	26.5	24.5	
6.0	34	300	11.75	4.8	0.98	3.5	38	28	26.5	
6.3	36	315	12.50	5.0	1.04	3.4	36	29.5	28	
6.7	38	335	13.00	5.4	1.08	3.1	35	32	29	
7.0	40	350	13.75	5.6	1.15	3.0	33	33.5	30.5	

Manvi

Installed by:

(Signature)

Date:

*Net coverage per bag may be increased 2% to 10% depending on joist spacings, widths, and depths using correction factors.

Fiber Glass Blowing Wool

Thermal Resistance To obtain an installed thermal resistance of: RSI	R	Bags per Unit Area The number of bags per net area shall not be less than: 100m²	1000 ft²	Thickness mm	inches	Weight 17 kg. 37.5 lb.
1.4	8	7.0	6.5	69	2.7	
1.8	10	8.5	8.0	88	3.4	
2.1	12	10.0	9.5	103	4.1	
2.5	14	12.0	11.0	123	4.8	
2.8	16	13.5	12.5	137	5.4	
3.5	20	17.0	16.0	172	6.8	
4.2	24	20.0	19.0	206	8.2	
4.9	28	23.5	22.0	240	9.5	
5.6	32	27.5	25.5	275	10.9	
5.9	34	28.5	27.0	289	11.6	
6.3	36	30.0	28.5	309	12.2	
7.0	40	33.5	32.0	343	13.6	

Installed Thermal Resistance:
Minimum Depth Installed:
Minimum Installed Weight per unit area:
Number of Bags Installed:
Date of Installation:
Installed by:

INSULATION PERFORMANCE DATA
CGSB STANDARD CGSB-51.9-M86 TYPE I
CGSB SPECIFICATION 51-GP-10M TYPE III
ASTM STANDARD C 764-85 TYPE I
FACTORY MUTUAL RESEARCH REPORT NO. 417
UNDERWRITERS' LABORATORIES REPORT NO. 905

COVERAGE CHART

R-VALUE	INCHES	MINIMUM COVERAGE Coverage per bag m²	MINIMUM COVERAGE Coverage per bag ft²	MINIMUM COVERAGE Thickness per bag (Min.) in.	MINIMUM COVERAGE Thickness per bag (Min.) mm	MINIMUM WEIGHT (Lbs./ft³)	MINIMUM WEIGHT (Kg/m³)	MINIMUM WEIGHT 1000 ft.²	MINIMUM WEIGHT 100 m²
R-60	20.3	4.11	44.2	20.00	508	1.82	29.2	44.1 lbs.	21.5 kg.
R-56	19.0	4.11	44.2	20.00	508	1.82	29.2		
R-52	17.6	4.11	44.2	20.00	508	1.82	29.2		
R-50	16.9	4.11	44.2	20.00	508	1.82	29.2		
R-49	16.6	4.11	44.2	20.00	508	1.82	29.2		
R-48	16.2	4.11	44.2	20.00	508	1.82	29.2		
R-44	14.9	4.11	44.2	20.00	508	1.82	29.2		
R-42	14.2	4.11	44.2	20.00	508	1.82	29.2		
R-40	13.5	4.11	44.2	20.00	508	1.82	29.2		
R-38	12.8	4.11	44.2	20.00	508	1.82	29.2		
R-36	12.2	4.11	44.2	20.00	508	1.82	29.2		
R-34	11.5	4.11	44.2	20.00	508	1.82	29.2		
R-32	10.8	4.11	44.2	20.00	508	1.82	29.2		
R-30	10.1	4.11	44.2	20.00	508	1.82	29.2		
R-28	9.5	4.11	44.2	20.00	508	1.82	29.2		
R-26	8.8	4.11	44.2	20.00	508	1.82	29.2		
R-24	8.1	4.11	44.2	20.00	508	1.82	29.2		
R-22	7.4	4.11	44.2	20.00	508	1.82	29.2		
R-20	6.7	4.11	44.2	20.00	508	1.82	29.2		
R-19	6.4	4.11	44.2	20.00	508	1.82	29.2		
R-14	4.7	4.11	44.2	20.00	508	1.82	29.2		
R-12	4.1	4.11	44.2	20.00	508	1.82	29.2		
R-10	3.4	4.11	44.2	20.00	508	1.82	29.2		

BUILDER'S APPLICATION STATEMENT AND SIGNATURE

This is to certify that the above installation has been completed in conformance with the requirements of the Code for Energy Conservation in New Building and the Building Code of Canada.

COMPANY NAME (APPLICATOR)

BUILDER'S SIGNATURE

APPLICATOR'S SIGNATURE

Insulation card that should be filled out and signed by installer.

LEBCO COMMENTARY

New energy performance standards for household appliances have been signed into law in the United States. Among the provisions is a performance standard (gas furnaces must have a minimum efficiency of 78% and gas boilers 80%).

Within the next 5 years, **all** appliances in the U.S. will be energy efficient - and few current products will remain on the market, as most will be unacceptable.

It is of interest to note that the industry is behind these measures, and in fact had to fight the Reagan Administration to accept the legislation (Reagan had vetoed the proposals at first).

So what does this mean for Canadians? We **used** to have energy performance ratings on appliances (the Energuide ratings) but that program was dismantled by the government - although that was only a first step, because it only dealt with **labelling** rather than with **mandated** standards - and it emphasized refrigerators and stoves rather than space heating appliances.

Why should new U.S. legislation be of interest to us?

Our economies are closely tied together, with many corporations doing business on both sides of the border. If free trade comes to pass, one can only assume that U.S. manufacturers will be quite anxious to dump their inefficient products that they have on hand (as well as continue with some production runs to maximize their return on current designs). There will be nothing to stop them from dumping product they cannot sell at home.

It is time to start a similar program in Canada, to ensure that we don't fall behind, and that we can benefit from products designed for Canadian conditions.

We have been leaders in the development of heat recovery ventilators - to the point that they now are efficient, world leading products. It would be unfortunate if Canadian industry were to fall behind, and be left at the mercy of outside decision makers. The time is right to start thinking ahead and improving the quality of products now, before it is too late.

The building community could help itself by encouraging manufacturers to upgrade their products, by insisting on using better quality products exclusively. It should also encourage the development of new standards. After all, if everyone in the industry has to comply to the same minimums, they do not become excessive or overly expensive. Unfortunately, it is a fact of life that in a competitive world where the bottom line is dominant, mandated minimum standards are the only means to ensure that everyone produces reasonable products. If such standards are not developed and implemented, the simple, tried and true solutions will keep on being used, even if they are terribly inefficient.

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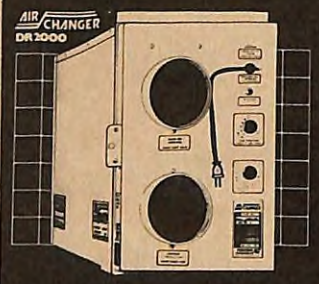

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